SE09

Fabrication, Magnetic, and High Frequency Characterization of the FeCoAl Ternary Thin Film

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Integration of ferromagnetic materials with electronic component represents a key solution to the enhancement of high frequency characteristics for recent miniaturized communication devices. In this study, Al elemant was introduced into FeCo binary alloy to from a ternary FeCoAl magnetic thin film by co-sputtering technique and subsequently annealing in presence of an external magnetic field. X-ray diffraction result revealed that the FeCoAl film exhibited a solid solution microstructure of FeCo matrix with Al as soluteelement. The saturation magnetization of FeCoAl thin film increased significantly as compared to FeCo alloy. It was found that the FeCoAl system possessed a high permeability around 1000 and an uni-axial anisotropic field 50 Oe. In addition, with the incorporation of Al element, the resonance frequency of the FeCoAl film reached 2.1 GHz. Hence, it is suggested that FeCoAl magnetic thin film is a potential candidate for high frequency devices operated in GHz bands.

SE10

High-Frequency Ferromagnetic Properties of NdFeBO Thin Films

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The magnetic materials operating at GHz bands are required having high saturation magnetization (Ms), appropriately high anisotropy field (Hk) to obtain a high ferromagnetic resonance frequency, and high electrical resistivity (ρ) to lower the eddy current loss. For satisfy these requirements, a Fe-based alloy containing Nd, B, and O elements was designed, where Fe atoms supply large magnetic moments, Nd and B atoms enhance the anisotropy field, and O atoms increase the resistivity of the film. 100-nm-thick NdFeBO film, covered by 30-nm-thick Ti film as a protecting layer, was deposited on (100) Si wafer by dc magnetron sputtering. The as-deposited film with amorphous structure exhibits a good high-frequency ferromagnetic properties of permeability over 200 and ferromagnetic resonance frequency (fFMR) of 1.32 GHz. It is interesting to note that the film annealed at 350 ℃ for 1 hour for nanocrystallization exhibits a dramatic enhancement in high-frequency properties. The fFMR excesses 3 GHz, while the relative permeability maintains over 100. The vibrating sample magnetometer results reveal that the annealed sample has a relatively high Ms of 15.7 kG and very high Hk over 1000 Oe. The resistivity (more than 10 Ωm) of the film is too high to be measured by four-point probing method. Consequently, the good high-frequency ferromagnetic properties can be attributed to the high values of Ms, Hk, and ρ. The FeNdBO film may be a potential candidate for fabrication of micro-inductor at GHz applications.

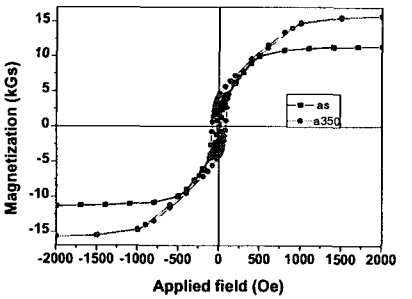

Fig.1. Hysteresis loops of as-deposited and annealed FeNdBO film

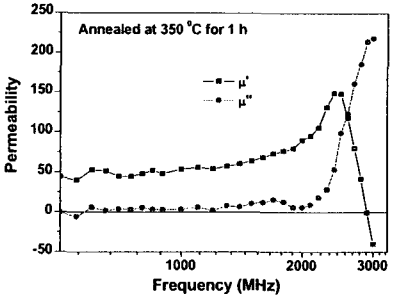

Fig. 2. Frequency dependence of permeability for the annealed FeNdBO film